Contributions to the Knowledge of the Alpheid Shrimp of the Pacific Ocean, IX Collections from the Phoenix and Line Islands[1]

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THIS PAPER initiates a series of three studies in the continuing series on the alpheids from the central Pacific that are based primarily upon collections made under the auspices of the Bernice P. Bishop Museum. In 1954 the senior author received a travel grant from the Bernice P. Bishop Museum and Yale University that permitted him to collect alpheids from wide areas in the central Pacific. The grant was made as part of the tri-institution program (TRIPP) of those two institutions and the University of Hawaii for the increase of scientific knowledge of the Pacific.

While collecting under the grant the Phoenix, Fiji, Tonga, Samoa, Cook, and Society archipelagoes were visited. In each group of islands the marine environment was sampled as thoroughly as possible, with windward and lee reefs, lagoon, and ocean habitats being examined. Wherever possible a rough transect was taken across the reef to the depths that could be reached by effective skin diving. Often, however, difficulties in transportation interfered with the collecting scheme. For example, it was impossible in the time available to reach the low islands in the Fijian Archipelago, or the Tuamotus. Moreover, strong winds and surf at times rendered collecting on the outer side of the ocean reef too dangerous. This occurred, for example, at Canton in the Phoenix Archipelago and at Tongatabu in Tonga.

Specimens from other collections have supplemented the collections made under the grant.

In addition to the Bishop Museum—Yale University grant mentioned above, this study was supported in part by a series of grants from the National Science Foundation (NSF-G-1754, 3863, and 9937).

As reported in Part VIII of this series, the specimens upon which this study is based were lost in a fire at the Hawaii Marine Laboratory. This paper is the one referred to as being held at the Bishop Museum at the time of the fire.

ENVIRONMENT DATA

Canton Island is an atoll in the Phoenix Group that lies at 2° 50′ S and 171° 43′ W; it is about 9 miles long by 4 miles wide, with an extensive and deep lagoon opening to the ocean only through a narrow passage on the western side. Rainfall is slight and there is no apparent runoff, even by seepage, unless during rare periods of torrential rains. All collections were made in the period from 27 February to 5 March 1954.

Description of Stations

Stations 1–9 were taken on the sandy edge of the western side of the lagoon near a deserted military pier where living and dead coral heads were scattered.

BC 1. Solid head of coral; 3 ft deep.

BC 2. Partially dead head of *Pocillopora* sp.; 3 ft deep.

BC 3. Solid but unattached head of dead coral; 3 ft deep.

BC 4. Massive head of dead coral covered with a thick algal mat; 3 ft deep. Some of the shrimp were in holes in coral under the mat, but more were living in the mat.

BC 5. Almost dead head of *Pocillopora* sp.; 3 ft deep.

BC 6. Massive and solid head; 3 ft deep.

BC 7. Heads of ramulose *Acropora* sp., with dead bases containing many openings and

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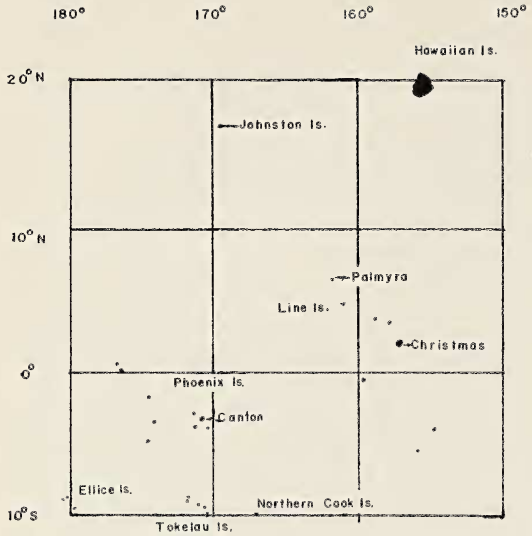

FIG. 1. Islands from which collections are reported upon in this study.

spaces; 6 ft deep. All shrimp collected were from the dead bases, none from the living *Acropora*.

BC 8. A dead, coherent head of coral; 6 ft deep.

BC 9. A dead head of encrusting coral with numerous large cavities and passages; 14 ft deep.

BC 10. From several solid coral fragments; 2–6 ft deep.

Stations 11–18 were along the ocean reef on the leeward (southwest) side of the atoll. Here the reef varied from about 140 to over 200 yards wide. The uppermost edge was a boulder rampart, with a sand beach below; below the sand zone there was a zone of consolidated beach rock, some wave-polished and some erosion-pitted. The reef flat proper was flat and without salient features except for occasional scattered boulders; its surface was covered with a dense algal mat about 1 inch thick. The seaward side of the reef was broken into surge channels without any coralline algal ridge.

BC 11, 12, 13. Coral blocks covered with algal mat found at end of surge channels.

BC 14. Heads of growing *Porites* sp. shaped like inverted wash pans; fourth head of similar shape, 15 inches in diameter and 4 inches thick, but dead and covered with a thick mat of algae; all from the middle reef flat at about 0 ft tidal level. On living heads and bases only about six alpheids were collected; but on the dead head specimens were numerous, most being found between the head and the algal mat, but with some occupying superficial holes and fissures in the head proper.

BC 15. Loosely consolidated masses of coralline algae, with many openings and passages; from head of surge channel, outermost reef.

BC 16. Consolidated coralline rock (apparently largely coralline algae); about 10 ft shoreward from head of surge channel.

BC 17. *Pocillopora meandrina* Verrill; from head of surge channel. All specimens except *A. lottini* Guérin and *Synalpheus charon* (Heller) from dead coral at base of head.

BC 18. Dead and overgrown head of *Pocillopora;* from middle reef flat, 40 ft from beach limestone margin.

Stations 19 and 20 were located on the flourishing coral growths immediately within the lagoon from the sole pass from the ocean. Here at both incoming and outflowing tides the current was so strong that slower boats could not breast it; collecting was possible only during periods of slack water. While all pieces of coral, living and dead, examined had a minimal alpheid population (only 24 specimens were collected in about 5 hr of work), the snapping of the shrimp was audible and indicated a much

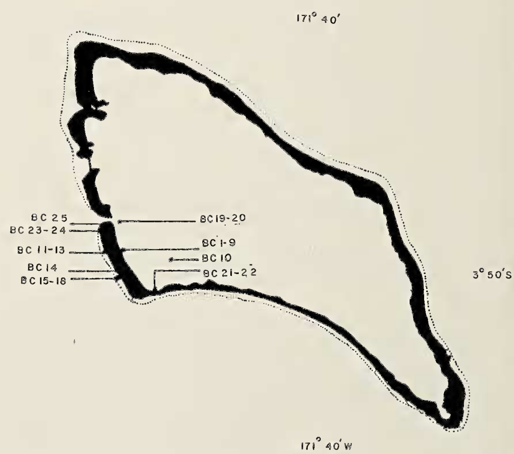

FIG. 2. Canton Atoll, Phoenix Islands, showing collecting stations. The dotted line indicates the 10-fathom depth. (Taken from U. S. Hydrographic Office Chart #5740.)

larger population; presumably the shrimp were deeper in the coral mass, impossible to collect with the equipment available.

BC 19. Dead coral heads in the −1-ft tidal level, few shrimp.

BC 20. Various corals, mostly dead massive heads; 6–20 ft deep.

Stations 21 and 22 were located on the broad intertidal beach of fine sand at the most southwesterly portion of the lagoon. Most of the beach was devoid of traces of alpheids (unless they were deep sand-burrowing species as those of the Brevirostris group). The specimens collected were found associated with scattered coral heads and boulders, living and dead, especially under coral and beachrock boulders resting in slight pools on the sand flat.

BC 21. Under scattered boulders, resting on sand; depths ranging from 0 to +1-ft tide level.

BC 22. Coral heads, mostly dead, from outer beach edge; at 0-ft tidal level or slightly below.

Stations 23–25 were from near the ocean side of the lagoon pass and within the pass. The ocean reef here was solid and flat, with few loose heads or boulders that could provide holes for alpheids; the pass proper was the result of blasting during World War II and had much dead coral.

BC 23. Specimens collected under flat coralline rocks in a shallow tide pool, where they were buried in tunnels and excavations in a thin sand layer; depth about +0.5-ft tide level.

BC 24. Attached, overgrown head of dead coral; depth about −1-ft tide level.

BC 25. Overgrown head of *Porites,* mostly dead, seaward portion of lagoon pass; about 6 ft deep.

Another small group of specimens came from Christmas Island, an atoll in the Line Islands lying at 1° 55′ N and 157° 20′ W. It has a land area of 234 sq miles. Areas plainly identifiable as being part of an extensive lagoon are now filled in, bridged across, and cut off, so the area within the outer ring of the island is a series of lagoons separated from the sea by land. Most of the isolated lagoons have high salinity and are apparently devoid of higher plant or animal life. As the main lagoon is approached from the filled portion of the old lagoon bed there are a series of sublagoons, separated from the main lagoon by broad shallow sills; the inner of these, too, are lacking snapping shrimp at least. The main lagoon and the reefs around the island are usual for tropical atolls and have the usual fauna. Some of the collections reported from this island were made in 1959 by the senior author, incidental to procuring poisonous fish, and some were made by members of the British Royal Air Force stationed on the island. Most of the collection is lacking in environmental data, but where possible notes on the environment are given under the species concerned.

Palmyra Island, like Christmas Island, lies in the Line Islands at 5° 52′ N and 162° 06′ W. The few specimens from this island were collected by the senior author in 1959 while studying poisonous fish there.

Johnston Island, lying at 16° 45′ N and 169° 30′ W, is represented in the collections by a few specimens loaned by the Bernice P. Bishop Museum and the U. S. National Museum.

J-1 to J-8 were collected in 1947 on the outer reef edge on the northwest side of the island by F. Bayer.

J-16. Outer reef at end of north seaplane channel. Collected in 1947 by F. Bayer.

24-9 Bishop Museum. Collected on Tanager Expedition in 1923. No further data.

1799 Bishop Museum. Same data as above.

10980 Johnston Island. Collected by Maxwell Doty. No further data.

AUTOMATE de Man

Automate gardineri Coutière

Automate gardineri Coutière, 1902. Mus. d'Hist. Nat., Bull. 8(5):337; 1905. Fauna and Geog. Mald. and Laccad. 2(4):854, figs. 127–128.

LOCALITY: 2 specimens from BC 21.

ATHANAS Leach

Athanas indicus (Coutière)

For synonymy, see Banner and Banner, 1960.

LOCALITY: 3 specimens from BC 11.

DISCUSSION: In the field notes on the collection from BC 11 it was remarked that "the small black alpheid of the lower genus probably *Arete*" was found in apparent commensal association with a black ophiuroid in the holes in the coral. Unfortunately, lack of facilities prevented further identification of the species in the field, and upon return to Hawaii it was found that three species of *Athanas* were collected from BC 11. Which of the species was associated with the brittle star is not known for certain, but the fact that the three specimens, somewhat fragmentary, of *A. indicus* were aberrant might indicate this species was the one. When an opportunity presents itself a series of the athanids associated with ophiuroids should be collected and contrasted with the *Echinometra*-associated *A. indicus*.

Athanas rhothionastes Banner and Banner 1960

Athanas rhothionastes Banner and Banner, 1960. Pacific Sci. 14(2):142–146, fig. 2.

LOCALITIES: 1 specimen from BC 11; 8, BC 13; 3, BC 24.

Athanas djiboutensis Coutière

Athanas djiboutensis Coutière, 1897. Soc. Philomath. Paris, Bull. 3(6):234; 1905. Fauna and Geog. Mald. and Laccad. 2(4): 856.

LOCALITIES: 1 specimen from BC 5; 5, BC 13; 7, BC 14; 4, BC 20; 1, BC 22; 2, BC 23.

Athanas dorsalis (Stimpson)

For synonymy see Banner and Banner, 1960.

LOCALITY: 24 specimens from BC 11.

SALMONEUS Holthuis

Salmoneus sibogae (de Man)

Jousseaumea sibogae de Man, 1910. V. Ned. Dierk. Ver. Tijdschr. II, 11(5):303; 1911. Siboga Exped. 39a[1](2):158, pl. 3, fig. 9.

LOCALITY: 1 small fragmentary specimen from BC 14.

DISCUSSION: While this specimen is lacking in most of its legs, the form of the rostrum and telson is similar to intact specimens of this species that will be reported upon in a later paper.

The name of this genus was changed by Holthuis in 1955:88.

ALPHEOPSIS Coutière

Alpheopsis equalis Coutière

Alpheopsis equalis Coutière, 1903. Soc. Philomath. Paris, Bull. IX, 5(2):89; 1905. Fauna and Geog. Mald. and Laccad. 2(4):869, fig. 138 a–b. Armstrong, 1941. American Mus. Nov. (1137):5–8, fig. 1, table X. Banner, 1953. Pacific Sci. 7(1):15–17, fig. 4 a–o.

Alpheopsis equalis truncatus Coutière, 1903. Soc. Philomath. Paris, Bull. IX, 5(2):89.

Alpheopsis consobrinus de Man, 1910. V. Ned. Dierk. Ver. Tijdschr. 11(5):305.

LOCALITIES: 1 specimen from BC 20; 1, BC 22; 1, BC 23; 2, BC 25. 1 specimen from Christmas Island.

Alpheopsis diabolus Banner[3]

Alpheopsis diabolus Banner, 1956. Pacific Sci. 10(3):325, fig. 3.

LOCALITY: 1 specimen from BC 23.

NEOALPHEOPSIS Banner

Neoalpheopsis hiatti Banner

Neoalpheopsis hiatti Banner, 1953. Pacific Sci. 7(1):21, fig. 6 a–l.

LOCALITY: 4 specimens from Christmas Island.

DISCUSSION: This is the second time *Neoalpheopsis hiatti* has been reported. Banner reported 4 specimens from Hawaii in the original description.

SYNALPHEUS Bate

Synalpheus paraneomeris Coutière

Synalpheus paraneomeris Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4): 872, pl. 71, fig. 7. Banner, 1953. Pacific Sci. 7(1):40–45, fig. 13 a–l; 1956, Pacific Sci. 10(3):351–353, fig. 15 a–d.

Synalpheus sluiteri de Man, 1920. Zool. Meded. 5:107.

[3] In the original description there is a typographical error in the name in the text; the name used on the plate, *Alpheopsis diabolus* is correct; moreover, the legs referred to in the bottom paragraph, left column, p. 327, are the third, not second, legs.

Synalpheus paraneomeris Edmondson, 1923. B. P. Bishop Mus., Bull. 5:30. (2 specimens from Christmas Island).

LOCALITIES: Canton Island: 2 specimens from BC 4; 1, BC 9; 11, BC 11; 3, BC 13; 7, BC 14; 15, BC 15; 9, BC 16; 8, BC 17; 24, BC 18; 3, BC 19; 14, BC 24; 2, BC 25. Christmas Island: 14 specimens. Johnston Island: 2 specimens from J–1; 2, J–5.

DISCUSSION: Our specimens display the variation as discussed by Banner (1953:41; 1956: 351) and Coutière (1905:872). However, among the large number of specimens at hand there are 4 in which the rostrum and orbital hoods are greatly reduced. These specimens include 1 from BC 17, part of a collection of 8; 1 from Tahiti (BD 2) from a collection of 104 specimens; 1 from Tonga (BT 17) from 2 specimens; 1 from Kapingamarangi #174 from a collection of 2 specimens. Since these strongly resemble the other specimens of the same species in their individual collections, we feel this reduction is simply malformation.

S. sluiteri was described by de Man as "closely related to *Synalpheus paraneomeris.*" However, de Man listed a number of characteristics in which the two species differed. Most of these differences, such as the proportions of the antennular peduncle, and the articles and dactyls of the third legs, are easily within the range of variation previously reported. Two possible differences remain: First, de Man stated that the "upper angle of basicerite subacute, a little prominent, though not spiniform." This description, without plates, could apply to the maximal development found in the specimens in these collections, or it may be markedly different. Second, the size of the ova, being 1.2–1.5 mm long as opposed to about 1.0 mm for near-mature eggs of our specimens. As egg diameters are influenced by the maturity of the embryo, and as poecilogony is known among the synalpheids, not much reliability should be placed on this difference. Therefore we have tentatively made *S. sluiteri* a synonym of *Synalpheus paraneomeris.*

Synalpheus kusaiensis Kubo (Journ. Imp. Fish. Inst. Tokyo, 34(1):87, fig. 10, 1940) is quite close to *S. paraneomeris* in its general form, its appendages, and other characteristics. However, the development of the squamous portion of the scaphocerite is markedly different from any specimens in these collections. In Kubo's figures the squamous portion reaches only to the end of the second antennular article and is only slightly more than half as long as the lateral spine, while the squame in *S. pareneomeris* is variable. It usually reaches to near the end of the third article and is about two-thirds of the length of its lateral spine. In none of the specimens did the squame approach the condition depicted for *S. kusaiensis.*

Synalpheus charon (Heller)

Alpheus charon Heller, 1861. K. Akad. Wiss. Wien, Sitzung. 44:272.

Synalpheus charon de Man, 1911. Siboga Exped. 39a[1](2):235, pl. 8, fig. 27–27c. Banner, 1953. Pacific Sci. 7(1):37, fig. 11 a–k.

LOCALITIES: 1 specimen from BC 17; 3, BC 25.

Synalpheus streptodactylus Coutière

Synalpheus neomeris streptodactylus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):870, pl. 10, fig. 1[1].

Synalpheus streptodactylus de Man, 1911. Siboga Exped. 39a[1](2):226, pl. 7, fig. 29.

LOCALITY: Canton Island: 2 specimens from BC 8.

Synalpheus tumidomanus (Paulson)

Alpheus tumidomanus Paulson, 1875. Recher. Crust. Mer. Rouge, p. 101, pl. 13, fig. 2.

Synalpheus tumidomanus Coutière, 1909. U. S. Nat. Mus., Proc. 36:24, fig. 5. de Man, 1911. Siboga Exped. 39a[1](2):258, fig. 43–43d.

LOCALITIES: 1 specimen from BC 9; 2, BC 10; 2, BC 25.

Synalpheus coutierei Banner

Synalpheus coutierei Banner, 1953. Pacific Sci. 7(1):37.

Synalpheus biunguiculatus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4): 873, pl. 71, fig. 8.

LOCALITY: Canton Island: 1 specimen from BC 8.

Synalpheus heroni Coutière
Synalpheus heroni Coutière, 1909. U. S. Nat. Mus., Proc. 36:42, fig. 24.

LOCALITIES: Canton Island: 1 specimen from BC 12. Christmas Island: 2 specimens.

ALPHEUS Fabricius

MEGACHELES GROUP

Alpheus collumianus inermis Banner
Alpheus collumianus inermis Banner, 1956. Pacific Sci. 10(3):342, fig. 12 a–i.

LOCALITIES: Canton Island: 1 specimen from BC 15; 1, BC 24.

Alpheus collumianus medius Banner
Alpheus collumianus medius Banner, 1956. Pacific Sci. 10(3):340, fig. 11 a–h.
Crangon collumianus Edmondson, 1923. B.P. Bishop Mus., Bull. 5:28. (6 specimens collected from Palmyra Island).

LOCALITY: Christmas Island: 1 specimen.

Alpheus oahuensis Banner
Alpheus oahuensis Banner, 1953. Pacific Sci. 7(1):64, fig. 20 a–l.

LOCALITY: Christmas Island: 1 specimen.

Alpheus deuteropus Hildgendorf
Alpheus deuteropus Hilgendorf, 1878. Monats. Berlin Akad. Wiss., p. 834, taf. 4, fig. 8.

LOCALITY: Christmas Island: 5 specimens.

DISCUSSION: These specimens were collected from fissures in a head of *Astreopora myriophthalma* found about the low-low tide zone on the ocean reef on the lee side of the island (near the old village site called Paris). Upon return to Hawaii several heads of *Porites lobata* Vaughn showing fissures were collected from about 6-ft water in Kaneohe Bay, Oahu. Each fissure had a pair of cohabiting *A. deuteropus.*

The fissures are usually up to about 10 cm long, but may be considerably longer; the width is 5 mm or less, and the depth usually about 2 or 3 cm. The fissures are in the living coral and their tops are at times flush with the head and at times depressed at the base of a "valley" between the lobes. They are usually sinuate and often have blind side branches 1 or 2 cm long. The shrimp appear to live at the base of the fissure, and when frightened they will withdraw into round blind tubes penetrating directly into the head of coral. In one head, the only one examined that cracked so as to permit the following of the tube, the tube penetrated about 2 cm and then bifurcated, with the branches lying at an angle of about 90° to each other and penetrating about 4 cm beyond the bifurcation; at the end of the branches were hidden alpheids, the male in one branch and the female in the other.

MACROCHIRUS GROUP

Alpheus lottini Guérin
Alpheus lottini Guérin, 1830. Voy. de la Coquille, Atlas, Crust. 5(2):38, pl. 3, fig. 3. Stebbing, 1915. S. African Mus., Ann. 25: 82. Barnard, 1950. S. African Mus., Ann. 38:748, fig. 141 e–j. Holthuis, 1958. Israel Sea Fish. Res. Stat. Bull. 17, Contri. Know. Red Sea No. 8, p. 22.
Alpheus ventrosus H. Milne-Edwards, 1837. Hist. Nat. Crust. 2:352.
Alpheus laevis Randall, 1839. Acad. Nat. Sci. Philadelphia, Journ. 8(1):141.
Alpheus obesomanus Boone, 1935. Vanderbilt Mar. Mus., Bull. 6:135. [partim]
Crangon ventrosa Banner, 1953. Pacific Sci. 7(1):84, fig. 28.
Crangon latipes Banner, 1953. Pacific Sci. 7(1):52, fig. 27.

LOCALITIES: Canton Island: 2 specimens from BC 2; 2, BC 17. Johnston Island: 1 specimen from J–1; 2, J–5; 2, J–6; 2, J–16; 2, J–17.

DISCUSSION: In the heads of *Pocillopora meandrina* examined at Canton Island it was noted that this species and *Synalpheus charon* (Heller) live in different zones in the live coral. *Alpheus ventrosus,* together with crabs of the genus *Trapezia,* lived in the portions more distal from the base, and *S. charon* lived in the most basal branches of the live coral.

It is with regrets that we follow Holthuis (1958:22) in changing the name of this species from the well-known *A. ventrosus* H. Milne-Edwards to the seldom-used *A. lottini* Guérin (in Guérin's description *lottini* is spelled *lottinii* but on the plates it is spelled *lottini.* The latter spelling takes precedence). Guérin's name does take precedence, but had Kingsley (1883) not published on a re-examination of the type in a long over-looked paper, the specimen name would have been a *nomen dubium,* for Guérin's figure and description were both inaccurate and non-specific (cf Banner, 1958:164). As a consequence Guérin's name was not used, and the two other names for the species, *A. ventrosus* and *A. laevis,* were used almost 80 times in the literature, and by such authorities as de Man and Coutière. However, *A. lottini* was used in 1893 (Sharp), 1915 (Stebbing), 1919 (Stebbing), 1950 (Barnard). So appeal cannot be made to the Internation Commission on Zoological Nomenclature for, according to the Article 23, Section (b), the name must be unused for at least 50 years before an appeal can be made to place it as a *nomen oblitum.*

Alpheus amirantei Coutière

Alpheus amirantei Coutière, 1908. Soc. Philomath. Paris, Bull. IX, 11(5):15–16.

LOCALITY: Johnston Island: 4 specimens collected by M. Doty, Sta. #10980.

DISCUSSION: This species, which is inadequately represented here, will be discussed in a subsequent paper.

Alpheus gracilis Heller

Alpheus gracilis Heller, 1861. K. Akad. Wiss., Wien, Sitzung. 44:271 taf. 3, figs. 19–20.

LOCALITIES: Canton Island: 1 specimen each from BC 9, 10, 18; 2, BC 11. Christmas Island: 2 specimens.

Alpheus clippertoni (Schmitt) new combination[4]

Crangon hawaiiensis clippertoni Schmitt, 1939. Smithsonian Misc. Coll. 98(6):12–14.

Crangon nanus Banner, 1953. Pacific Sci. 7 (1):90, fig. 30 a–m.

Alpheus nanus Banner, 1956. Pacific Sci. 10 (3):345.

Alpheus huikau Banner, 1959. Pacific Sci. 13(2):139–140, fig. 5 a–e.

Nec *Crangon nanus* Krøyer, Naturhist. Tidsskr. 4(3):231.

LOCALITIES: Canton Island: 4 specimens from BC 11; 4, BC 12; 6, BC 16; 1, BC 24. Christmas Island: 1 specimen.

DISCUSSION: Dr. Fenner A. Chace, Jr., of the U. S. National Museum examined the type specimens of *A. hawaiiensis clippertoni* (Schmitt) and other specimens of *A. nanus* (Banner) and found them to be identical; the grooves on the large chela that Dr. Schmitt had indicated as barely perceptible were found to be prominent (Chace, in a personal correspondence). Therefore the name *huikau,* as the name *nanus* before it, must be cancelled, and the subspecific name applied by Schmitt must be raised to specific rank.

In 1937 Chace erected a new genus, *Pomognathus,* for a new species of alpheid (*P. corallinus*) from the waters of Baja California (1937: 124, fig. 5). The new genus was separated from *Alpheus* by the lack of epipods on the thoracic legs, and from *Synalpheus* by "the larger chela of the first pair of legs and the opercular third maxillipeds."

Yet *Alpheus paragracilis* Coutière and *A. clippertoni* (Schmitt) show very close relationship to this genus and species. In the three species, the form of the orbital hoods, the development of the rostrum, the general proportion of the antennular and antennal peduncles, the development of the thoracic legs and telson show what appears to be a modification at the specific level of the same fundamental plan.

In the Indo-Pacific species the mouthparts protrude in a conspicuous fashion, from an over-development of the anterior labrum and a hemispherical expansion of the incisor process of the mandible. The outer mouthparts are quite normal for the genus except for the third maxillipeds, the base articles of which are broad, flattened, and curved to enclose the more anterior appendages. In *A. paragracilis* this article is not expanded, but in *A. clippertoni* the article is expanded slightly, but not as much as in *P. corallinus* (Fig. 3).

Fundamental to this consideration is the branchial formula of the species involved. According to definition, all members of *Alpheus* have five pleurobranchs, one arthrobranch, and eight epipodites, with the last mastigobranch on the fourth walking legs, and the last setobranch on the

[4] While this paper was in press Chace published on this new combination and indicated the same synonymy in U. S. Natl. Mus. Proc. 113(3466):609, 1962.

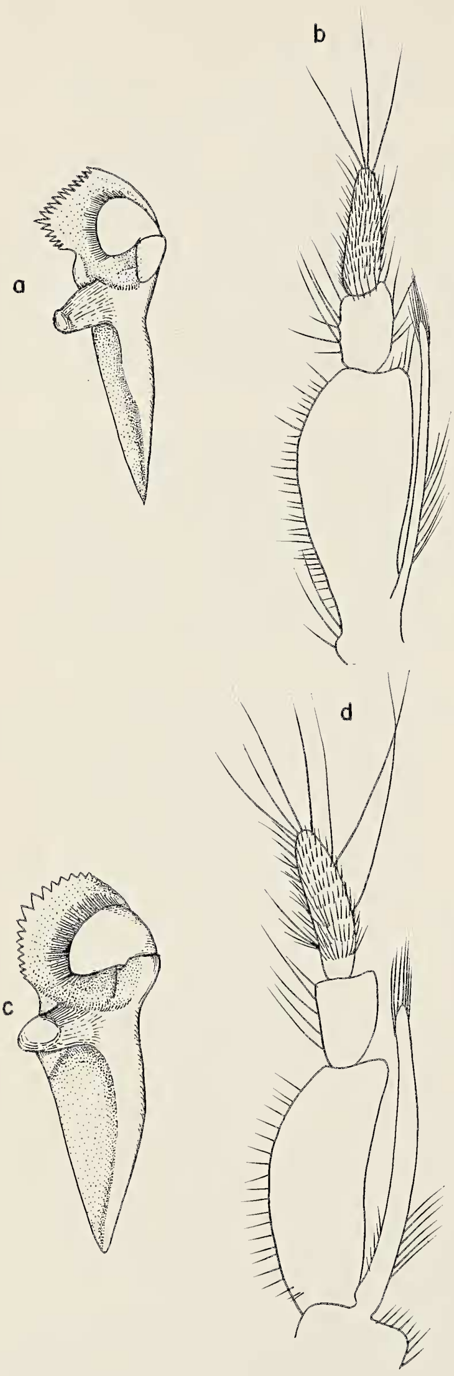

FIG. 3. Mouthparts of *A. clippertoni* (Schmitt) and *A. paragracilis* Coutière. *a, b,* Mandible and third maxilliped of *A. clippertoni; c, d,* mandibles from third maxilliped of *A. paragracilis.*

fifth walking legs. In *Pomognathus* there are "no epipods on any thoracic legs."

A group of 60 specimens of *A. paragracilis* from much of the range represented in the collections (Society, Cook, Samoa, Tonga, Hawaii, and Marshall islands) were examined; of these 58 lacked the last mastigobranch and setobranch normal for *Alpheus,* with the final epipodites occurring on the third and fourth walking legs. One had a rudimentary mastigobranch on the fourth, with no setobranch on the fifth, therefore approaching the condition normal to *Alpheus;* and the last lacked the mastigobranch on the third leg, approaching the condition of *Pomognathus.* In 30 specimens of *A. clippertoni* from a similar geographic range all specimens were like the normal *A. paragracilis,* with the last mastigobranch on the third and the last setogranch on the fourth. The question is, how much reliance should be placed on the branchial formula as an absolute generic criterion? Certainly the formula is not fixed in *A. paragracilis,* nor is it constant in other genera (see Banner and Banner, 1960:134).

To us it appears that *Pomognathus corallinus* is an extension of the line of modification found in *A. paragracilis* and *A. clippertoni,* both in structure of the mouthparts and in branchial formula. *Pomognathus* does not show close relationship, in our opinion, to *Synalpheus,* and the reductions of the epipodites in *Pomognathus* is merely parallel to that of *Synalpheus.* It is possible that additional species may be found intermediate between *A. paragracilis* and *P. corallinus;* if they are found, the whole series should be reconsidered. However, for the present we believe that the *A. paragracilis* and *A. clippertoni* should be retained in *Alpheus,* and *Pomognathus* should be considered as a distinct genus.

Alpheus macrochirus Richters

Alpheus macrochirus Richters, 1880. Meeresfauna der Insel Mauritius und der Seychellen, Decapoda, p. 164, pl. 17, figs. 31–33.

Nec *Alpheus macrochirus* de Man, 1888. Arch. für Naturgesch. 53(1):519.

LOCALITIES: Canton Island: 1 specimen from BC 14; 1, BC 16. Christmas Island: 5 specimens.

Alpheus edmondsoni Banner
Alpheus edmondsoni Banner, 1953. Pacific Sci. 7(1):78, fig. 26 a–p.

LOCALITIES: Christmas Island: 5 specimens.

DISCUSSION: Dr. Doty, one of the collectors of this species cited in our 1959 paper (Pacific Sci. 13:141), has corrected what was an apparent misinterpretation of the label of the specimen. The citation should read "Oneroa Island, Raroia Atoll. Tuamotu Archipelago . . . collected by Morrison, Doty, and Herre. . . ."

OBESOMANUS SUBGROUP

Alpheus obesomanus Dana
Alpheus obesomanus Dana, 1852. U. S. Explor. Exped. p. 547, pl. 34, fig. 7.

LOCALITY: Canton Island: 1 specimen from BC 24.

Alpheus malleodigitus (Bate)
Betaeus malleodigitus Bate, 1888. Challenger Rpts. 24:565, pl. 101, fig. 5.
Alpheus malleodigitus de Man, 1902. Senckenb. Naturf. Gesell., Abhandl. 25:866.

LOCALITIES: Canton Island: 1 specimen from BC 8; 3, BC 11; 3, BC 13; 2, BC 24.

DISCUSSION: The characteristics, name, and synonymy of this species will be discussed in a future paper.

The one specimen, a male, in BC 8 is apparently malformed. In all characteristics except the antennules and antennae it is like the usual specimens of this species, but the antennules, while symmetrical, are very short, so that the typically reduced scaphocerite reaches to the middle of the third article, and one carpocerite reaches to the end of the antennular peduncle while the other exceeds it by about one-fourth its length. This appears to be the result of an accident of inheritance or of environment.

CRINITUS GROUP

Alpheus ovaliceps Coutière
Alpheus ovaliceps Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):888, pl. 77, fig. 27.

LOCALITY: Canton Island: 1 specimen from BC 14; 1, BC 16; 3, BC 24.

Alpheus bucephalus Coutière
For synonymy see Banner and Banner, 1957.

LOCALITIES: Canton Island: 1 specimen from BC 1; 4, BC 4; 2, BC 6; 4, BC 8; 4, BC 9; 4, BC 10; 1, BC 22.

Alpheus bradypus Coutière
Alpheus bradypus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):891, pl. 78, 79, fig. 30.

LOCALITIES: Canton Island: 2 specimens from BC 4; 8, BC 6; 1, BC 8; 1, BC 11; 7, BC 16; 1, BC 24.

Alpheus brevipes Stimpson
Alpheus brevipes Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:30.
Crangon brevipes Banner, 1953. Pacific Sci. 7(1):103, fig. 35 a–j.

LOCALITIES: Canton Island: 2 specimens from BC 11; 4, BC 17. Johnston Island: 2 specimens from J–8. Christmas Island: 8 specimens.

Alpheus clypeatus Coutière
Alpheus clypeatus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):897, pl. 81, 82, figs. 36–36g.
Crangon clypeata Banner, 1953. Pacific Sci. 7(1):107, figs. 37, 38, 39.

LOCALITY: Johnston Island: 1 specimen from J–4.

DIADEMA GROUP

Alpheus ehlersii de Man
Alpheus ehlersii de Man, 1909. Zool. Soc. London, Proc. 1909:663, pl. 70, fig. 106.
Alpheus macrochirus de Man, 1888. Archiv. für Naturg. 53:519.
Nec. *A. macrochirus* Richters, 1880, and other references.

LOCALITY: Canton Island: 1 specimen from BC 12.

Alpheus diadema Dana
For synonymy see Banner, 1956.

LOCALITIES: Canton Island: 1 specimen each from BC 1 and 18; 10, BC 14; 3, BC 22.

Alpheus paracrinitus Miers

Alpheus paracrinitus Miers, 1881. Ann. and Mag. Nat. Hist. V, 8:365, pl. 16, fig. 6.

Crangon paracrinitus Edmondson, 1923. B. P. Bishop Mus., Bull. 5:29. (Four specimens from Palmyra Island).

LOCALITIES: Canton Island: 5 specimens from BC 1; 2, BC 2; 1, BC 4; 2, BC 5; 1, BC 6; 2, BC 9; 3, BC 20; 5, BC 25. Christmas Island: 15 specimens.

The separation by Holthuis (1958:25) of *A. paracrinitus* into two species, and the examination by Chace (1962:609) of West African specimens of *A. paracrinitus* will be discussed in a future paper; it is sufficient here to state that we recognize the Indo-Pacific species as *A. paracrinitus* Miers.

Alpheus gracilipes Stimpson

Alpheus gracilipes Stimpson, 1861. Acad. Nat. Sci. Philadelphia, Proc. 12:31.

LOCALITIES: Canton Island: 3 specimens from BC 5; 2, BC 22.

EDWARDSII GROUP

Alpheus leviusculus Dana

Figure 4

Alpheus edwardsii leviusculus Dana, 1852. U. S. Explor. Exped. 13:543, pl. 34, fig. 3 a–f.

Alpheus leviusculus de Man, 1911. Siboga Exped. 39a[1](2):411, pl. 23, fig. 98 a–b.

Crangon leviusculus Edmondson, 1925. Bernice P. Bishop Mus., Bull. 27:15.

Nec *Alpheus leviusculus* Bate, 1888. Challenger Rpts. 24:549, pl. 93, fig. 1.

Alpheus bouvieri bastardi Coutière, 1898. Soc. Ent. de France (5):132, fig. 1a.

Alpheus bouvieri A. Milne-Edwards, 1878. Soc. Philomath. Paris VII, 2:231.

Nec *Alpheus bouvieri hululensis* Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):908, pl. 85, fig. 46.

LOCALITIES: Canton Island: 1 specimen from BC 18. Wake Island: 5 specimens including the 9.8-mm male described below. Johnston Island: 7 specimens.

DESCRIPTION:[5] Specimen described with anterior body displaced from under carapace.

Rostrum triangular, short, not reaching to middle of first antennular article, lateral margins slightly concave with curve continuous with orbito-rostral front; in lateral view, tip somewhat depressed (that of female shown in drawing is crushed downward). Orbito-rostral grooves shallow and broad, interorbital crest slight and rounded, merging with the carapace near posterior margin of eyes. Orbital hood slightly inflated, hemispherical, frontal margin only slightly arcuate.

Second antennular article slightly longer than broad, longer than the third article, shorter than visible portion of first article (some of the length visible of first article may be from displacement of body). Stylocerites short, acute, slightly exceeding end of first article. Basicerite with strong lateral tooth, slightly shorter than stylocerite. Lateral margin of schaphocerite almost straight; lateral spines slightly exceeding length of antennular peduncle. Carpocerite exceeding length of antennular peduncle by length of last article.

Third maxilliped with first and last article equal in length, about twice length of middle article; tip of third article abruptly truncate and bearing numerous heavy setae, some of which equal article in length.

Large cheliped with merus twice as long as broad, bearing two weak spines and a seta on inferior internal margin; superior margin rounded distally, inferior internal margin terminated by small tooth. Chela almost three times as long as broad, with outer palmar face bearing triangular depressed area arising from transverse groove and continuing proximally to *linea impressa;* lower shoulders pronounced, but not continuing more than one-fifth width of face. Inner face of palm without marked depressions. Dactylus heavy, one third length of entire chela, tip rounded.

Small cheliped with merus similar to that of large chela in armature, but with face 2.5 times as long as broad. Palm without sculpturing, 1.7

[5] This description and these figures were to be of specimens to be designated as neotype and neoallotype; however, the specimens were lost in the Hawaii Marine Laboratory fire.

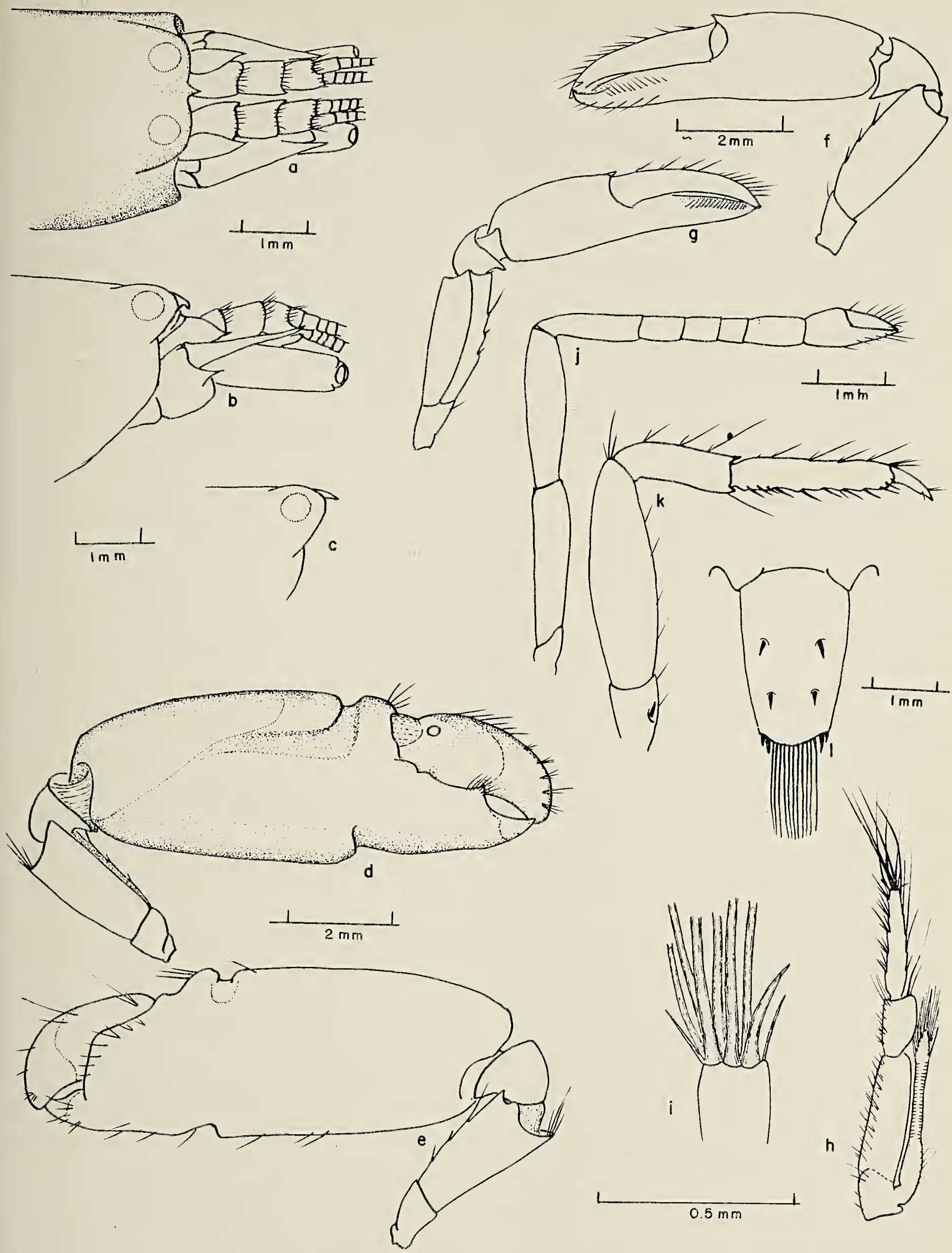

FIG. 4. *Alpheus leviusculus* Dana, male and female, from Wake Island. *a,* and *b,* Anterior region, female, dorsal and lateral aspects (note that rostral tip is crushed downward, and body is displaced anteriorly); *c,* anterior carapace male, showing normal rostrum; *d* and *e,* large cheliped male; *f,* small cheliped, male; *g,* small cheliped female; *h,* third maxilliped of male, exterior or lower view; *i,* third maxilliped tip (not all setae of back side shown); *j,* second leg, male; *k,* third leg, male; *l,* telson, male.

times as long as broad, terminating in small but distinct tooth above dactylar articulation. Fingers not *balaeniceps*-shaped, bearing, however, slightly broadened opposing faces with slight row of setae on the margin; fingers equal in length to palm. Small chela of female is of similar form and armature, but about four-fifths as long as that of male.

Carpus of second leg with ratio of secondary articles as 10:5.1:2.8:2.8:5.4.

Third leg with small movable spine on ischium. Merus unarmed, 3.7 times as long as broad, with distal end about 0.6 as broad as middle. Carpus 0.5 times as long as merus, 3.0 times as long as broad, with relatively small teeth terminating superior and inferior margins. Propodus 0.7 as long as merus, about 6.0 times as long as broad, bearing 9 movable spines on inferior margin, scattered setae on superior margin. Dactylus 0.21 as long as merus, slightly curved, acute, and with slight thickening at point where secondary unguis might occur. Fourth legs similar to third.

Telson 1.6 times as long as broad anteriorly, with posterior margin 0.6 times as broad as anterior; lateral margins slightly arcuate, with uniform curve; distal margin broadly arcuate; superior and distal spines usual.

DISCUSSION: In the collection loaned to us from the Bishop Museum there was a group of five specimens from Wake Island, the type locality for Dana's species. Unfortunately, three of the specimens were small and the other two, which had been selected to be the neotype and allotype, were somewhat broken. However, the group of specimens from Johnston Island, which lies about the same latitude and only 1,600 miles away were almost identical with the Wake Island specimens and were in good condition. Both groups were used in preparing this description.

Dana's description of *A. leviusculus* is general enough to cover several species in the Edwardsii group. However, his figures are clear and do agree with our specimens except in two characteristics. First, there extends down the inner face of the large chela from the groove on the top margin a well-demarked U-shaped depression, while in Dana's figure no depression is shown on the inner face of the chela. This difference is likely to be the result of faulty delineation. Second, the spine above the movable dactylus of the small chela is not shown. However, this character may be variable, as in *A. paracrinitus* Miers, or the chela as drawn by Dana could have been so rotated that the spine was not visible.

Alpheus leviusculus Bate definitely does not belong to this species, being easily distinguished by the awl-like shape of the rostrum, the extended flattened areas between the orbital hoods and rostral base, and the relatively smooth large chela. It should also be noted that *A. leviusculus* is found on the reef flat while Bate's sole specimen came from 20 fathoms. His specimen does not appear to be similar to any other species within the group or the genus, so we propose, therefore, to apply to it the name of *Alpheus batesi.*

Our specimens also agree well with those of de Man (1911:fig. 98) except in the third leg. In de Man's specimen the merus of the third leg was five times as long as broad, while the maximum length-breadth ratio found in these 45 specimens is 4.4 times as long as broad.

Alpheus leviusculus was considered by de Man to be closely related to *A. bastardi* Coutière and *A. bouvieri* A. Milne-Edwards. The points of difference between these nominal species in relation to the variations of the 45 specimens in this collection are discussed herewith:

Rostrum length. The rostrum of *A. leviusculus* in Dana's figures and in these specimens is roughly triangular and reaches only slightly beyond the middle of the first antennular article. The grooves beside the rostrum are shallow. The rostrum of *A. bouvieri* is reported to be similar. However for *A. bastardi,* Coutière (1898) states that the rostrum is "Très faible et très obtuse, large, conique . . ." and that it is not separated from the orbital hoods by grooves, yet in the figures of both the 1898 and 1905 works he indicated slight grooves. In these specimens the length of the rostrum, when compared to the first antennular article, appears to be influenced by the displacement of the carapace in capture (the carapace appears to be easily displaced, as it is in *A. clippertoni* [see under *C. nanus* Banner, 1953, fig. 30]). The grooves flanking the rostrum exhibit the expected variation; some are very shallow, approaching the condition that Coutière indicated in fig. 1a (1898) and fig. 45 (1905) for *A.*

bastardi, the others are deeper but still shallow in relation to other species. In other words, the orbito-rostral area varies from an almost flat condition to a condition with shallow, ill-defined grooves.

Ratio of antennular articles. In *A. leviusculus* Dana shows the antennular articles to be almost equal. de Man (1911) pictures the second article slightly longer than the first, and the third a little shorter than the first, with the second article less than 2 times as long as broad. The type specimen is reported by Coutière 1898 (text and fig. 1) to have the second antennular article 1.5 times as long as the first and twice as long as broad, with the third article slightly shorter than the first. *A. bastardi* (loc. cit., fig. la) has all the articles of the antennular peduncle almost the same length and the second article as long as broad. However, Coutière in his 1905 plates (pl. 85, figs. 44, 45) shows specimens of *A. bouvieri* and *A. bastardi* to be almost exactly the reverse of the differential proportions of his 1898 figure. Obviously Coutière himself did not put much reliance upon this criterion for the species.

In our specimens the ratio of the lengths of the antennular articles range from 1:1.1:1 to 1:1.5:1 and the length-breadth ratio of the second articles ranged from 1 to 1.5 times as long as broad. These figures seem to bridge the differences among the three species in question, especially in view of the confusion of Coutière in the proportions of his species.

Antennular squame and spine. A. leviusculus as figured by Dana (fig. 3a) had a narrow squame, with the external spine about half the length of the third antennular article. The outer margin was slightly curved. *A. bouvieri* is similar. *A. bastardi* carries a slightly broader squame with a straight margin, and a spine which reaches only slightly beyond the end of the squame. The range of the relative proportions of the squame and spine in our specimens encompasses the differences reported for the three species.

Large cheliped. The chelae for the three species in question are without distinguishing characters and have similar length-breadth ratios. However, no writer has mentioned the slight spines that are almost always to be found on the inferior-internal margin of their meri, nor the blunt terminal tooth on this edge. These differences may be individual variation.

Small cheliped. There are two minor differences reported in the small cheliped. First, de Man (1911:412) describes a small spine above the movable dactylus which Coutière does not mention for either *A. bouvieri* or *A. bastardi.* This tooth appears in all of these specimens. Second, in 1905, Coutière described and figured a moderately well-developed setiferous crest on the dactylus of the males of *A. bouvieri* which he uses as a criterion to separate the species from *A. bastardi,* where it is lacking. Neither Dana nor de Man mentioned this character for *A. leviusculus.* In our series most specimens were without the crest, yet in two males a crest of poor development was found along the inner side of the movable dactylus.

Third leg. The only other point of difference is the merus of the third leg. In 1905 Coutière stated that the length-breadth ratio of the third leg of *A. bouvieri* is 3.5 and in *A. bastardi,* 4.5. Dana pictures the third leg merus of *A. leviusculus* to be 3.5 times as long as broad. de Man's sole specimen had a ratio of 5. The merus in our series ranges from 3.1 to 4.4 times as long as broad.

It is apparent that the subtle differences separating *A. leviusculus, A. bouvieri,* and *A. bastardi* are either within the range of variation found in the specimens of this collection, or represents only slight extensions of the range. We have, therefore, placed the two latter species in synonymy.

Three other species are related to this complex: *A. bouvieri hululensis* Coutière (1905:908, pl. 85), *A. coutieri* de Man (1911:409, fig. 97), and *A. ladronis* Banner (1956:360, fig. 20).

The description of *A. bouvieri hululensis* is so inadequate that without the re-examination of the type specimen, or, better, of a topotypic series, it is impossible to ascertain its true relationship. While we believe that it may be found to be within the range of variation of *A. leviusculus,* yet on the basis of specimens described its rostrum appears to be specifically distinct. Therefore, we suggest that this described form be retained under the name of *A. hululensis* until additional specimens are examined.

A. coutierei is obviously closely related to *A. bouvieri hululensis.* Like *A. hululensis* it can be distinguished from *A. leviusculus* by the base of the rostrum and the long rostral carina. It will be discussed more fully in a later paper.

A. ladronis Banner, while related, can be readily separated from *A. leviusculus* by the large chela. The top groove of the large chela in *A. ladronis* is shaped almost exactly like that of *A. crassimanus,* with the proximal margin of the groove gradually rounded instead of abrupt, as in *A. leviusculus.* Further the spine on the inferior internal margin of the large chela is large and subterminal in *A. ladronis,* while in *A. leviusculus* it is small and terminal. In many of the males of *A. ladronis* one finds a *balaeniceps* condition, while in *A. leviusculus,* when a fringe of hairs is found it is thin and does not pass over the top of the dactylus. The merus of the small chela also bears a large subterminal spine on its inferior-internal border. The rostral carina is sharper and can be plainly seen from above, whereas in *A. leviusculus* the animal must be rotated to make the slight carina visible. Finally, although the proportions of the merus of the third leg are variable in both species, that of *A. ladronis* (20 specimens) averages 4.6 times as long as broad, while that of *A. leviusculus* averages about 4.0 times; the extremes of the ranges of the two species overlap.

Alpheus crassimanus Heller

Alpheus crassimanus Heller, 1865. Reise der Novara, Crust. p. 107, pl. 10, fig. 2.

LOCALITIES: Canton Island: 4 specimens from BC 18; 1, BC 19.

Alpheus pacificus Dana

Alpheus pacificus Dana, 1852. Acad. Nat. Sci. Philadelphia, Proc. 6:21.

LOCALITIES: 1 specimen from BC 23. Christmas Island: 12 specimens.

Alpheus strenuus Dana

Alpheus strenuus Dana, 1852. U. S. Explor. Exped. 13:543, pl. 34, fig. 4.

LOCALITIES: Canton Island: 2 specimens from BC 14; 14, BC 23. Christmas Island: 2 specimens.

Alpheus funafutensis Borradaile

Alpheus funafutensis Borradaile, 1898. Zool. Soc. London, 1898:1013, pl. 65, fig. 10. de Man, 1911. Siboga Exped. 39a¹(2):436.

Alpheus hippothoe edamensis de Man, 1897. Zool. Jahrb. Abth. Syst. 9:757; 1902, Senckenb. Naturf. Gesell. 25:891.

Alpheus acanthomerus inermis Lanchester, 1901. Zool. Soc. London, Proc. 11(1):564.

LOCALITIES: Canton Island: 11 specimens from BC 14; 3, BC 18.

DISCUSSION: These specimens agree well with Borradaile's original pictures and description and de Man's (1911) further notes. Some minor variations were noted. The rostrum varied from one-half to three-fourths the length of the first antennular article. The rostral keel always extended back to the bases of the orbital hoods but was less broad than that pictured by Borradaile (fig. 10a). Some of the keels were quite sharp while others were slight. The tips of carpocerite and scaphocerite reached variously from slightly beyond the end of the antennular peduncle to a distance equal to the length of the third article beyond that article. The squame, which was narrow, sometimes reached to the end of the second antennular article or to the end of the third, and in all cases the spine extended well past the end of the antennular peduncle. Borradaile in his original description remarked that the fingers of the small chela were elongate, yet he pictured them as stubby and shorter than the palm; our specimens agree with the figure. The small chela resembles very closely that of *A. parvirostris* Dana. The most distinctive characteristics of this species are the granulation and hairiness on the inside of both the large and small chela.

Alpheus parvirostris Dana

Alpheus parvirostris Dana, 1852. U. S. Explor. Exped. 13:551, pl. 35, fig. 3.

LOCALITIES: Canton Island: 7 specimens from BC 1; 2, BC 2; 3, BC 3; 4, BC 4; 6, BC 5; 4, BC 7; 6, BC 8; 7, BC 9; 25, BC 10; 2, BC 19; 10, BC 20; 3, BC 22; 2, BC 25.

THUNOR Armstrong

Thunor microscaphis Banner

Figure 5

Thunor microscaphis Banner, 1959. Pacific Sci. 8(2):151–154, fig. 13 a–i.
Thunor sp. Banner, 1956. Pacific Sci. 10(3): 367–371, fig. 23.

LOCALITY: 1 ovigerous female from BC 13, carapace length 4.9 mm.

This specimen has a slightly longer scaphocerite than the type specimen, a male from the Marshall Islands, and the female from Saipan, but the article is shorter than that of the male from Saipan. Except for the telson there is almost perfect agreement in other parts.

In the three specimens previously described the tendency to develop dorsolateral ridges on the telson, leaving a median groove, was noted; on this specimen these ridges are pronounced and actually rise above and curl over the median groove. Because of the inward rolling of the posterior portion the terminal truncation of the telson, when seen in dorsal view, appears to be almost a point. Unlike telsons previously reported for the family, both the lateral and the terminal setae extend beyond the posterior lateral spines, which are very poorly developed, and lie along the dorsal ridges projecting over the medial groove. Only one of the four dorsal spinules normally found could be seen. The outer uropod, without a trace of the transverse articulation, also has its outer margin rolled upward, and the sutural spines seem to be lacking; the distal margin of this uropod bears a series of short movable spines. Both the outer and inner uropod bear many long setae; on the latter they are along the middle of the superior surface.

This development of the telson may be found to be a characteristic adequate to separate this specimen as a new species; however, until more mature female *T. microscaphis* are studied, it seems more logical to consider this specimen as merely a more mature stage of the species already described.

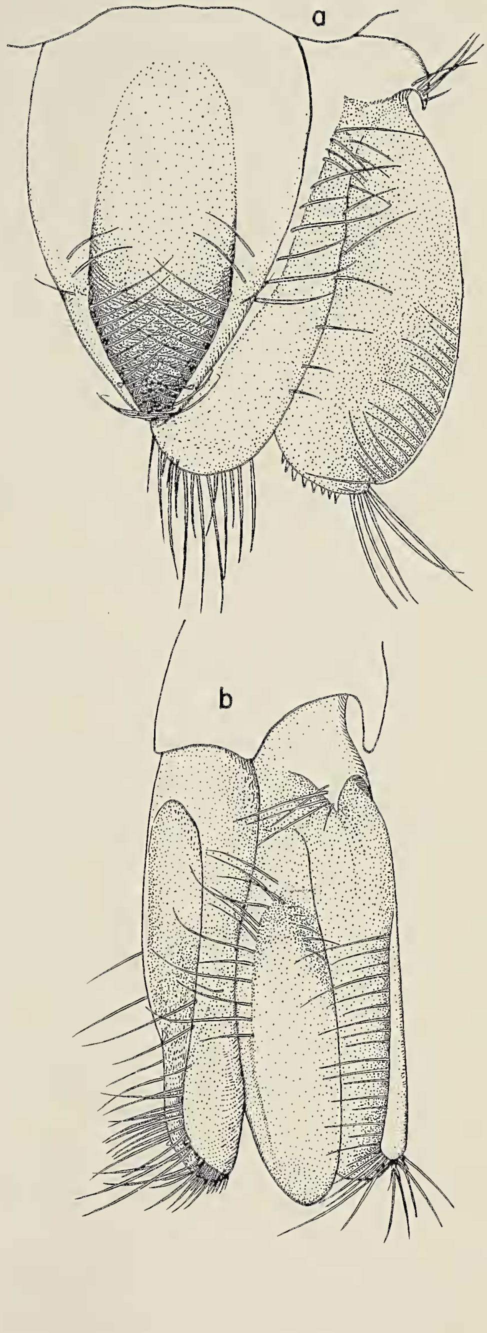

FIG. 5. *Thunor microscaphis* Banner. Female from Canton Atoll. Telson and uropods: *a,* dorsal view; *b,* lateral view (at a slight angle).

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